X-ray Microtomography of Polymer Blends

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Introduction: Polymer blends compounded for tires, bladders and vibration mounts frequently contain carbon black or other fillers that make them intractable to optical or electron microscopy. We have applied x-ray microradiography and microtomography to explore the internal structure of these commercially important materials. In-service performance can be related to the number, size and distribution of voids and both organic and inorganic particulates. The cure state of polymers containing bromine-initiated crosslinks can be inferred from images acquired using absorption edge crossing techniques.

Methods and Materials: Specimens of several formulations of carbon black filled, zinc oxide crosslinked blends of isobutylene-p-methylstyrene-p-bromomethylstyrene and isobutylene were examined before and after mechanical test using absorption and multiple-energy microtomography to study the structure/performance relationship. Attenuation and elemental images were acquired with resolutions from 1 to 10 microns/pixel.

Results: The 3D images of linear attenuation coefficient and bromine and zinc concentration reveal the uniformity of the blend and a variation in cure chemistry at the component interface. Both the uniformity and interface properties relate well to mechanical performance and provide important insights for modifying compounding methods to improve performance.

Conclusions: Multiple energy x-ray microradiography and microtomography provide perhaps the only methods to image the internal structures affecting blend performance. Unanticipated structural and compositional variations have been identified and related to mechanical properties.

References: J. Dunsmuir, J. Dias, D. Peiffer, R. Kolb, and G. Jones "Microtomography of Elastomers for Tire Manufacture," Developments in X-ray Tomography II, 3772, 86, Proc of SPIE 1999